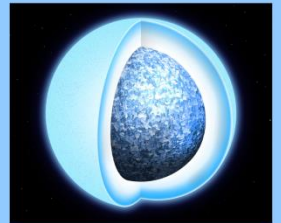


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## S2 E5: What If Our Sun Became a White Dwarf Star?

### Sun as a White Dwarf

EPISODE 5



ASTROPHYSICS: DEEP IN THE SPACE  
WITH MAANVINDER PILANIA

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# What If Our Sun Became a White Dwarf Star?

Hello and welcome back to another episode of this astronomy podcast and I'm your host and it's time to finally embark on another adventure through our cosmos. Last season, I told you guys about some scenarios regarding the future of Sun like what if our Sun became a black hole, red giant star and black dwarf. One scenario out of these three will never come true and that is the one about black hole because Sun does not have mass enough to become a black hole instead it will become a black dwarf, which is the last evolutionary stage for a main sequence star. Before that happens, Sun will become a red giant star by growing its outer layers, engulfing planets and moons, etc. It is after this stage that is a new stage called White Dwarf and in this episode we will be discussing about it.

What is white dwarf? It's not that hard to understand if you can understand the common science behind it. Our Sun is a main-sequence star which means it burns hydrogen to helium in a process called fusion, which is how it produces energy and light. When it runs out of fuel, it begins to fuse helium and other heavy elements produced inside it and will take the charge to prevent the star from collapsing under its own gravity. In this stage, the Sun's outer layers begin to expand outwards. It is balanced by the star's own gravity and the outward pressure from ongoing thermonuclear process. Roughly 5 billion years from now the Sun will enter the Red Giant phase. There comes a time it will run out of it as well and shed its outer layers because there will be no more thermonuclear reaction to prevent it from collapsing under its own gravity. When it will shed its outer layers, it will form a planetary nebula such as Carina Nebula. It is just like a supernova however there is one difference. In the blast of outer layers, Sun will throw all the elements and stuff into the outer space making a nebula, leaving a small sparkling jewel. It will continue to shine due to thermal heat from the process going inside it. However, it does not mean the Sun's mass will also reduce to that of the Earth. According to Dr. John from NASA's Goodard Space Station, the Sun will lose its 50% mass affecting the entire solar system. The sun will become dense and it will have an intense gravitational pull due to the electron degeneracy pressure. In this process the electron gets squeezed together, the more the electron gets squeezed, the denser the star gets. This pressure prevents white dwarfs from collapsing however; it does set a limit on it.

Earlier it was believed that all main-sequence stars turns into white dwarf and does not undergo supernova. This was changed when an Indian-American astrophysicist Subrahmanyan Chandrasekhar discovered a limit called Chandrasekhar Limit. According to this limit, a white dwarf can also become a neutron star by undergoing a supernova called Type Ia Supernova if the mass of white dwarf is about 1.4 times that of the Sun. Another way to go supernova is if it gains mass and this is possible if it

comes in a contact with a red giant star, which usually happens in a binary star system where one is in red giant phase and the other is in the white dwarf. As red giant has lower control on its outer layers due to it being only supported by the thermonuclear reactions pressure, the white dwarf will begin to collect or in other words steal the material from its companion red giant until it reaches a point called Chandrasekhar Limit where it will undergo a supernova explosion, resulting in a neutron star. This possibly leaves a white dwarf and a neutron star because the continues flow of material from red giant to white dwarf causes the process of the other red giant turning into white dwarf gets increases and it loses its outer layers before it has a chance to burst the layers on its own naturally. So is it possible in case of Sun? if you were paying attention you would know that our Sun will never undergo this process of becoming a neutron star let alone a black hole. First if its mass was 0.4 times more than it has, it would have certainly undergone a supernova. Another reason is that there is no close star for our sun to collect material to reach that limit. So yeah, its safe to say that deadly fate is not in our sun's evolution stage.

With this thing I would like to draw your attention towards one more thing, when our Sun will be in its red giant phase, it will engulf everything till Jupiter according to latest models. That means our planet will be gone, the mars will be gone, the asteroid belt will be gone. The question that arises here is will life exist then? Then answer might be yes because when the Sun will be near Jupiter, its habitable zone will gets shifted beyond Jupiter's orbit, somewhere around Pluto, Neptune and Kuiper Belt, possibly giving life a second chance to thrive. However, I'm not sure of the fate after that because when Sun will blow its outer layers, which mean it will blow up everything in its wake. Astronomers used to think that there will be no planets orbiting it until they discovered one white dwarf with planets. Now we know planets can still orbit an white dwarf. For example, WD 1586 b is a Jupiter sized exoplanet orbits the white dwarf every 34 hours. It was discovered by NASA's Spitzer Space Telescope while analyzing data from NASA's TESS mission in which transit method is used to discover new planets. I will explain about this in the next episode. Another such example is of SDSS J1228 which is just the metal core of a dead planet, revolving around a white dwarf. White dwarfs also have their own habitable zone. That means when our Sun becomes a white dwarf, the habitable zone will once again gets shifted back from Pluto to a new place, where if a planet survived the outburst of sun's layers, the liquid water on it might exist if it is revolving inside this zone. That is for the future to decide. White dwarfs take billions of years to cool down and when they do, the last stage will be turning into a black dwarf if it is a white dwarf with mass no more than 1.4 or more than that. White dwarf has thin atmosphere of hydrogen and beneath it lies a thick surface of helium around 30 miles thick whose interior is made of superheated carbon and oxygen because it is these elements whose electrons gets squeezed to make a white dwarf denser. The surface temperature of a white dwarf can be as hot as half million degrees but over the course

of billions of year, it will cool down to a point when it will be remain left as a cold dark ball lurking in the space and planets or any celestial body will still be orbiting around it except one thing that will change. It will be pure darkness and darkness for anyone to stand there, thus bringing an entire star system to its silent and dark death.

That is from me now until we meet again for the next episode. Stay tuned!!

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